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ABSTRACT

The education process of hearing-impaired students in 18 public secondary mathematics classrooms was examined in order to account for achievement and social adjustment differences between 11 mainstreamed and 7 self-contained classrooms. The classrooms were compared on the following dimensions: (1) social interactions among students, (2) teacher training/experience, (3) teacher verbal behaviors, (4) teacher expectations as perceived by students, (5) parental expectations as perceived by students, (6) exposure to course content, and (7) student participation. Data came from teacher questionnaires, teacher logs, live observations of classes, and student questionnaires. Results indicated no interaction between the hearing and hearing-impaired students in the mainstreamed classrooms. The teachers in the mainstream classes had more training in the subject matter, as well as more experience as teachers. The teachers' verbal behaviors differed significantly, independent of the type of classroom. Teacher and parental expectations were not a factor. Mainstreamed classes received more work and more difficult work than the self-contained classes. Hearing-impaired students in both types of classrooms asked more questions than hearing students did. Cited are several important factors impacting achievement of the hearing-impaired, such as their initial abilities, family situation, and quality of teaching received. (JDD)

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ACADEMIC AND SOCIAL INTERACTION FOR HEARING IMPAIRED HIGH SCHOOL STUDENTS

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Recent research into the academic achievement and social adjustment of hearing impaired adolescents in public school programs has shown two consistent trends. First, the academic achievement of these students has generally been more positive for students in mainstreamed classrooms as compared to their peers in self-contained classrooms (Allen & Osborn, 1984; Kluwin & Moores, 1985; Mertens, in press). Second, the social adjustment, self-image, or other affective measures of schooling outcomes have been more negative for mainstreamed hearing impaired students who have been in classrooms where social interaction has not been facilitated by special interventions (Farrugia & Austin, 1974; Ladd, Munson, & Miller, 1985; Mertens, 1986 & in press).

A consistent limitation of all the previous work on the integration of hearing impaired adolescents is that it has looked at the relationship between placement and outcomes without considering differences in classroom process that might affect these outcomes. Previous studies have failed to address two significant questions. First, are these differences due to differences in classroom processes between the two types of placements that operate over and above the influence of demographic characteristics of the students? Second, assuming that classroom process differences do account for the differences in outcomes, what are the important differences?

When Allen and Osborn (1984) controlled for background differences between students in mainstreamed and self-contained classrooms, they found that differences in achievement disappeared. However, Kluwin and Moores (1985) reported significant differences in achievement in high school math classes, even after background characteristics were controlled for. They hypothesized that other variables in the environment could explain the differences in achievement, such as teacher expectations, exposure to course content, training of the teacher, influence of family variables, and academic support in the form of tutors or interpreters.

The present study included an investigation of differences between mainstreamed and self-contained classrooms in terms of teacher expectations, student exposure to course content, training of the teachers, and the influence of family variables. In addition, the social interaction of the students and the verbal interaction between the teacher and students were examined.

Hearing impaired students are mainstreamed into classrooms with their normally hearing peers based on the assumption that social

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and academic benefits would accrue to the hearing impaired students by observing and interacting with normally hearing peers (Antia, 1982). Most previous research on social interaction of hearing impaired children has been done in preschools (Brackett & Henniges, 1976; Craig, 1975; Craig & Douglas, 1976) or with grade school children (Antia, 1982). One focus of the present study was to examine the social interaction of hearing impaired students in different settings at the high school level.

Another important influence on the academic achievement of students is the quantity and quality of interaction with the teacher (Bloom, 1984). Berliner (1982) summarized several characteristics of successful teaching including pacing the learners, sequencing events, monitoring success, controlling time, and running an orderly and academically focussed workplace. Kluwin (1984) used these categories to identify successful and unsuccessful teachers in residential schools for the deaf. There was a fundamental style difference between the teacher who was able to keep his or her class of hearing impaired adolescents on task. The successful teacher maintained a brisk but unhurried pace, structured the lesson, and monitored performance on the task rather than responding to the personality of the student.

Referencing other work, particularly the research specific to mathematics achievement on verbal behavior of teachers points to the fact that there are decided style differences between successful and unsuccessful teachers. There are five general categories of differences in the verbal productions of effective mathematics teachers including questioning, pacing, feedback, student participation, and clarity. Teacher questioning is marked by process questions which call for explanations and by frequent use of questions (Evertson, Emmer, & Brophy, 1980; Friedman, 1976). The frequency of the teacher's questions is also a way of operationalizing the notion of lesson pacing which in effective mathematics classes is marked by greater levels of interaction between the teachers and the students (Gregory & Osborne, 1975). Feedback is another feature of the effective teacher of mathematics in that the feedback provided to the students is varied and encouraging (Evertson, Emmer, & Brophy, 1980). Student participation in the effective mathematics classroom is frequent and oriented towards the clarification of principles. Effective teachers of mathematics are clear teachers. There is a relatively high correlation between students comprehension scores and their ratings of teacher clarity (Campbell & Schoen, 1977; McConnel, 1977; Smith, 1977; Bush et al., 1977). Finally, students achieve in effective mathematics classes because they are exposed to demanding material (Michigan State University, 1985).

The purpose of the present study was to examine the process of the education of hearing impaired students in public school programs in order to describe differences that might account for achievement and social adjustment differences. To this end, mainstreamed and self-containted classrooms were compared on the

following dimensions:

1. Social interactions among students
2. Training and experience of teachers
3. Teacher verbal behaivors
4. Teacher expectations as perceived by the students
5. Parental expectations as perceived by the students
6. Exposure to course content
7. Student participation in class

PROCEDURE

Sample. The study included 18 teachers of mathematics at the secondary school level, 11 teachers in regular mathematics classes with hearing students and hearing impiared students and 7 teachers in self-contained classes for the deaf. The teachers for this study came from three different schools in three cities, one in the Northeast and two in Texas. Of the 18 teachers, 5 were male. One of the teachers was hearing impaired and taught a self-contained class. All had at least 5 years of teaching experience with an average of 12 years of teaching for the entire sample. Three of the teachers were black, the rest were white. All had completed bachelor's degrees and were certified at the state level as secondary school teachers, although the specific areas of certification varied. The average number of hearing impaired students in a self-contained class was 6.4 while the average number of hearing impaired students in a mainstreamed class was 2.4. The average number of students in a mainstreamed class was 23.7.

Data Collection. Data for this study came from teacher questionnaires, teacher logs, live observations of classes, and student questionnaires.

Teacher questionnaires. The purpose of these questionnaires was to collect demographic information on the teachers as well as information on certain kinds of instructional behavior which is not readily observed in the classroom. The questionnaire asked for information on the teacher's age, sex, training, and previous experience as well as the use of specific types of instructional practices.

Teacher logs. These were open-ended reporting forms whose purpose was to collect information on the quantity and difficulty of the work that students were required to complete. The logs asked for information about the materials used in the class, the number of pages of text covered, and the number of problems worked. A coding scheme was developed where the content for general mathematics, algebra, and introductory trigonometry were arranged in a twelve level hierarchy from simple mathematical operations such as addition and subtraction of whole numbers to advanced topics in solving triangles. A thirteenth category was created to include special topics such as statistics and computer programming, but this was not needed in the coding process. All of the logs were coded for the amount and type of work that the students were required to do.

Live observation instrument. The classroom

observation isntrument that was used was an adaptation of the SRI Secondary Observation Instrument (Stallings, Needels and Stayrook, 1979). It provides a record of activities that occur in the in the classroom and the quality of the interaction between the teacher and the students and the interpreter and the students if an interpreter is present. The instrument is intended to record different instructional methods, intepersonal interactions, and types of classroom settings. The instrument uses a time sequence, sampling procedure. Five minute segments of classroom interaction are observed five times during a lesson. Every teacher or student "move" is recorded during that five minute period. In addition, at the start of every five minute interaction cycle, the instructional situation in the classroom is noted including details such as the materials used, lesson focus, and group structure.

Observer training. Three observers, one for each school, were trained over a four day period. Training included an explanation of the category system, short practices on videotaped lesson segments, and two days of alternating classroom observation practice and debriefings.

Observation schedule. Each teacher as an individual was observed at least five times and some as many as eight times because they taught more than one class. The total number of class periods observed was 79, 51 mainstreamed and 28 self-contained.

Student questionnaires. This was a 48 item questionnaire developed at the Center for Studies in Education and Human Development at Gallaudet College. In a preliminary pliot test of the attitude inventory with mainstreamed hearing impaired students, the reliability of the instrument was .85 as measured by Cronbach's alpha coefficient. Tentative sub-scales for the questionnaire based on the pilot test included sub-scales on the teacher's verbal behavior, student interpersonal contact, and parental attitudes and expectations. The scale consists of a series of statements followed by a Likert scale to indicate agreement with the statement.

RESULTS

Social Interaction. The number of interactions that occurred in both mainstreamed and self-contained classrooms between and among students was quite low. These classes were not structured to encourage interaction between the students. In the mainstreamed classrooms, no hearing student interacted with a deaf student and no deaf student interacted with a hearing student. The espoused goal of mainstreaming to encourage interaction between hearing impaired and normally hearing students was not achieved in the observed classrooms.

Social comments by individual hearing students were frequently observed in all the mainstream classes for a total of 325 social comments for the entire observation period. In five of the mainstream classrooms, no social comments were observed coming from the hearing-impaired students. A total of 24 social

comments were observed in the other five classrooms. In the self-contained classrooms, a total of 26 social comments were observed from the students. When these totals are corrected for different class sizes, it appears that the average hearing student makes 1.25 social comments per observation period, while the mainstream deaf student makes an average of .09, and self-contained student of .65. It is possible that the raters did not record these behaviors accurately for the hearing impaired student because they could have been using sign language to make a comment.

Training and Experience. All but one of the mainstream teachers (8 of 9) had their bachelor's degree in mathematics or math education. Only one of the six teachers in a self-contained classroom had a bachelor's degree in a math-related field. At the master's level, two of the eight mainstream teachers had a degree in mathematics or math education; none of the self-contained teachers did. Seven of the mainstream teachers were certified to teach in mathematics; none of the self-contained teachers were so certified.

Overall, there was no difference between teachers in mainstreamed and self-contained classrooms in terms of the number of years that they had been teaching. The mainstream teachers had been in the classroom for 12.78 years and the self-contained teachers for 10.83 years, however, this difference was not significant. Of those years spent in the classroom, the mainstream teachers spent a larger number of years teaching mathematics than the self-contained teachers did (12.44 vs. 7.83), and the self-contained teachers spent a larger number of years teaching hearing impaired students than did the mainstream teachers (9.33 vs. 3.67).

Teacher Verbal Behaviors. Eight different verbal behaviors were recorded for the teachers, including:

1. TASKQ-Teacher asks task-related questions.
2. TASKR-Teacher makes task-related requests.
3. FEEDB-Teacher gives neutral feedback.
4. GUIDE-Teacher guides the learner (e.g. You are almost right but I want more feedback.)
5. PRAISE-Teacher praises the student.
6. CTASK-Teacher gives a command related to the task at hand.
7. CDISC-Teacher gives a command related to discipline (e.g. Stop talking.)
8. PROGRESS-Teacher asks questions that monitor progress on the task.

A MANOVA was conducted to compare the two groups of teachers on these eight behaviors. The results of the analysis revealed no significant difference overall for the two types of classrooms(Pillais = .48, Approx F = .91, df = 8, $p < .55$). The only significant difference at the univariate level was for the variables PRAISE ($F = 5.65$, $p < .031$). The means suggested that the mainstream teachers used less praise than did their

counterparts in the self-contained classrooms.

While no differences were found between mainstream and self-contained teachers, major differences appeared within each group in terms of the frequency of each behavior. A significant amount of variability was found within each group on all eight behaviors using the Chi Square statistic. In other words, differences in teachers' verbal behaviors were not indicated between teachers in self-contained and mainstreamed classrooms. However, the teachers differed significantly from each other, independent of the type of classroom that they were in.

Other differences were noted in terms of the amount of individual and group contact experienced by the students. In the mainstreamed classrooms, 53 percent of the time was spent in individual contact. Of this 53 percent, 3.5 percent of the interactions occurred with the hearing impaired students(the balance was with their normally hearing peers). Accounting for differences in class size, normally hearing students experienced 4.0 individual contacts per 140 minute observation, while their hearing impaired classmates experienced .3 individual contacts with the teacher. These contacts do not include any contacts that the hearing impaired student experienced with the interpreter or a tutor. In the self-contained classrooms, 69 percent of the contacts were of an individual nature. Due to smaller class sizes, this represents an average of 28.1 individual contacts per 140 minute observation period per student. Clearly the hearing impaired students in the self-contained classroom recieve a higher percentage of individual contacts with the teacher than do their peers in mainstreamed classrooms.

Teacher Expectations. A factor analysis of the Student Attitude Questionnaire revealed one factor that was labeled Teacher Expectations. It consists of such items as: The teacher expects us to learn; The teacher tells us why something is important; and The teacher asks questions that make me think. Students were divided into three groups: students in the self-contained classroom, mainstreamed students whose ability level matched the level of their peers in the self-contained classroom, and a group of higher performing mainstreamed students. A comparison of the factor scores for these three groups did not reveal any differences on this varibale. It could be that the instrument was not sensitive enough to pick up true differences in experienced expectations, or the students' reading levels could have invalidated the results.

Parent Expectations. The same factor analysis of the Student Attitude Questionnaire discussed above indicated a factor that was labeled Parent Expectations. This consisted of such items as: My parents check my homework; My parents care about my school work; and My parents help me with my homework. A comparison of the factor scores for the three groups of students yielded no significant differences. Variables similar to those mentioned for the Teacher Expectations results could account for

these results as well.

Exposure to content. The quantity and difficulty of the work that students were required to complete were obtained from the teachers' logs. Using a scale that ranged from 1 to 12 with 12 indicating the most difficult type of problem, the average level of difficulty for the mainstreamed classrooms was 4.81 (sd = 2.74), while the self-contained teachers assigned problems with an average difficulty level of 1.82 (sd = .94). An ANOVA between groups indicated that this was a significant difference ($F = 6.51$, $df = 1,14$, $p < .0231$). The quantity of problems were computed per day to be 15.19 for the mainstream classes and 11.17 for self-contained classes. The was also a significant difference.

Student Participation. In four of the six self-contained classrooms, the students asked questions of the teacher. In one mainstreamed classroom, hearing impaired students asked twelve questions, and in another they asked one question. However, hearing students in the mainstreamed classrooms were not observed asking any questions.

DISCUSSION

Before discussing the implications of the results of this study, several cautions should be noted. Fist, the sample of schools, teachers, and students was finite, not randomly selected, nor representational of a larger population. This limits the generalizability of the results. Second, actual measures of academic achievement and social adjustment are not available for the students in the present study. The purpose of the study was to examine processes of education that might account for differences in achievement and social adjustment, therefore, the study focuses only on these differences in processes, and not on predicting outcomes.

The results indicated no interaction between the hearing and hearing impaired students in the classroom. Antia (1982) has argued that physical prowimity is a necessary but not sufficient condition for promoting interaction between hearing and hearing impaired children. A teacher must devise carefully plnned situations to encourage and increase social interaction between hearing impaired students and their peers. The lack of social comments generally by mainstreamed hearing impaired students may be an artifact of the measurement system, but it could also provide evidence of a restrictive social experience in high school. This could be related to the problems of social adjustment reported in previous research (Farrugia & Austin, 1974; Ladd, Munson, & Miller, 1985; Mertens, in press). Further research would be needed to investigate this phenomenon.

Mainstreamed teachers were more often trained in mathematics and math education, and they had more years of experience in teaching math that did teachers in self-contained classrooms. These differences in training and experience are important because

prospective mathematics teachers spend the bulk of their time studying only mathematics with a smaller percentage of time devoted to education courses. Traditionally, training programs in education of the deaf have concentrated on speedch, language, and communication skills, with little or no time devoted to subject specialty. The teachers in the mainstream mathematics classes had more training in the subject matter, as well as more experience as teachers and subject matter specialists. Walberg (1984) suggested that such teacher espertise makes a significant contribution to student achievement.

Bloom (1984) indicated that the quantity and quality of interaction with the teacher has a significant influence on the academic achievement of students. The fact that no differences between the mainstream and self-contained classroom teachers were found for teacher verbal behaviors could be a function of number of variables. Rater reliability, particularly for one of the raters, was unfortunately low. Other explanatory variables might include small sample size, or the insensitiviy of the observation instrument for detecting behaviors that truly differentiate between the two groups. However, the tremendous variablity of the teachers' behaviors within each group indicates that effective and ineffective teachers can be found in both types of classrooms. Future research could provide insight into effective and ineffective classrooms and teaching practices within a mainstreamed environment, or within a self-contained environment.

The lack of interaction at an individual level between the teacher and the hearing impaired student is similar to findings reported by Saur, Popp, & Hurley (unpublished manuscript). In their research they found that normally hearing students showed higher frequencies of interaction than their hearing impaired classmates. In addition, hearing impaired students seemed to take part in some classes, but not in others. The classes where the greatest interaction took place between teachers and hearing impaired students were those in which the teacher used simultaneous communication. Saur et al. point out that the lack of interaction in classrooms where an interpreter is used is due to communication lag time and instructors could be made aware of this constraint and strategies to deal with it.

The lack of differences in perceived teacher and parent expectations could again be the result to variablity among the teachers that washed out groups differences. In addition, it is possible that these differences do not exist, although this seems unlikely in light of Bodner-Johnson's (1985) research on the effect of family variables on achievement.

Students in mainstreamed classes were exposed to more content via problems to be solved in their math classes than were students in self-contained classrooms. The quantity of problems was more and the difficulty level of the problems was higher. This indicates that the students in the mainstream classrooms were generally working at a higher level in the area of math. It is possible that the students in the self-contained classes could not handle

the more difficult concepts, however, this would seem to be an individual by individual decision, and none of the students in the self-contained classes were exposed to a difficulty level higher than three (on the twelve point scale), with three of the self-contained classes functioning at the lowest level.

The lack of student participation in class suggests that these teachers do not structure their classes to encourage questions from any of their students, whether they be deaf or hearing. Again, Saur et al.'s (unpublished) suggests tremendous variability in terms of the amount of participation that is encouraged in classes. If instructors structure their classes to encourage participation, they it will occur.

A coherent interpretation of the results of this study might be that the largest single factor in the achievement of hearing impaired students in public school programs is their initial abilities. A second factor is the constellation of family factors. A third factor is the exposure to course content that is reflected by the difficulty and frequency of problems that are required of the student. Fourth, teacher training and experience in the subject area specialty may be a contributing factor. The fifth factor has to do with the quality of teaching. As the results of this study have indicated, a tremendous variability in teaching behaviors exists among the teachers in the public schools. Further research is needed to facilitate effective teaching behaviors in whatever setting a student finds him/herself. Finally, opportunities for interaction between teachers and students and amongst the students themselves contribute to a student's social emotional development. These interactions will not occur unless they are structured into the situation. Experimental studies should be designed in teacher training to determine the effect of such structured activities and changes in teachers' behaviors on the improvement of students' academic achievement and social adjustment.

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